![NUI Galway OÉ Gaillimh]

Semester 2 Examinations 2017 / 2018

Exam Code(s)	4BCT, 4BP
Exam(s)	Fourth Year Computer Science and Information Technology
	Fourth Year Electronic and Computer Engineering
Module Code(s)	CT414
Module(s)	Distributed Systems
Paper No.	1
External Examiner(s)	Dr. J. Howe
Internal Examiner(s)	Prof. M. Madden
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Instructions: Answer any 4 out of the 5 questions.
All questions carry equal marks.

Duration	2 hrs
No. of Pages	4
Department(s)	Information Technology
Requirements	None

1. Using Java Remote Method Invocation, write the Java code for a remote compute server application that could be used to remotely execute arbitrary Task objects. The server allows clients to submit Task objects, i.e. objects that implement the Task interface, for remote execution on the server, and clients are then returned the result as a Java object. The design of the system should make it possible for new Task classes to be easily added to the system in the future, making the system very flexible. The design should use Java RMI and Object Serialisation to submit Task objects and to return the result back to the client.

   The following Java interfaces / classes should be provided:

   - *Compute* - this remote interface should provide a method to upload Task objects to the server and to then run the task and return the result back to the client when execution is complete.   4 MARKS

   - *Task* - this interface should define an arbitrary task object that may be passed as a parameter to the compute server.   4 MARKS

   - *MathTask* – this class provides an implementation of the Task interface and is used to perform some calculation that returns an Integer object. The calculation itself can be just some simple arithmetic e.g. add two numbers.   6 MARKS

   - *ComputeServer* - this class should provide an implementation of the Compute interface as well as the code required to initialise the server and make the remote object locatable for clients in the RMI registry. The server runtime should be protected so that objects uploaded to the server can not cause any harm.   6 MARKS

   - *ComputeClient* – this should provide a simple client program that creates a MathTask object and submits it to the server for remote execution and then displays the result. The client runtime should be protected so that objects downloaded from the server can not cause any harm.   5 MARKS

2:a: What is *message oriented middleware* and what types of messaging models are available in the Java Messaging Service? 5 MARKS

  b: You are required to design an application that allows programmers to submit votes for their favourite programming language. Describe a suitable architecture and design for a distributed application that uses the Java Messaging Service (JMS) to submit these votes as messages to a queue. Another related application should similarly use JMS to consume these messages from the queue and tally votes. Full Java source code is not required but your answer should provide a full description of how the JMS could be used within the application. Also describe how the application might use the Java Naming and Directory Interface (JNDI) as part of this solution. 10 MARKS

  c: Assume that you have been contracted by a large multinational company to develop an enterprise class client / server application that may be accessed by a large number of clients concurrently. You will therefore need to employ some form of load balancing in the design of the application. What type of load balancing algorithm would you recommend? Are there any alternatives available? Provide some technical justification and rationale for your recommendations. 10 MARKS

3.a: Describe briefly the advantages of using the EJB component framework in the context of high volume distributed object applications. What types of beans may be defined using the EJB framework? 5 MARKS

  b: Web Services represent an evolution and convergence of a number of important areas of technology and business. Describe briefly these technology areas and explain how Web Services builds on previous capabilities. Include in your explanation an overview of the main enabling technologies used to provide Web Services. 10 MARKS

  c: You have been asked to develop a commercial online bookstore using J2EE based technologies. The bookstore architecture and design should be able to support different types of client browsers and should use a three-tier application model i.e. a client tier to support different clients, a middle tier that implements the application business logic and an information tier to persist the application state. Based on these requirements, describe the top-level application architecture. Identify the technologies that will be used and explain the role each of these technologies plays in the overall system architecture. 10 MARKS

4.a: Explain the role of the Proxmox Virtualisation Environment. In this context, what is the difference between a Virtual Machine and a Container?   6 MARKS

b: How is it possible to run Virtual Machines at near native speed using Kernel-based Virtual Machine (KVM) infrastructure?   4 MARKS

c: What is the purpose of the Ceph storage platform and what advantages does it have over traditional RAID based storage? Describe the high level architecture and the main components of the Ceph storage platform. Include in this description details about the following items: Ceph Network, Object Storage Devices and Ceph Pools.   8 MARKS

d: What are the advantages of grouping physical servers into a cluster? How does a Proxmox cluster implement High Availability and what might cause a Virtual Machine migration to fail?   7 MARKS

5.a: What types of services are typically available from commercial Cloud Computing providers? Provide some examples of each of these services in your answer.
                 5 MARKS

b: Suppose you work for a social media company that collects a lot of very large data sets e.g. web logs or other application related data that needs to be stored and analysed. Also assume that the company has access to large scale computing resources based in multiple data centres. Explain how using the Apache Hadoop Distributed File System and its related facilities might help in solving the storage and analysis requirements of the company. Discuss the advantages of this approach over using traditional database systems for this type of data.
                 8 MARKS

c: Describe in detail the MapReduce programming model. Outline the architecture for a MapReduce application that could be used to read in a block of text, count how many words in the block that begin with each letter of the alphabet (e.g. 2067 words begin with A, 172 words begin with B, ...), and print out the results. Full source code for the application is not required but your answer should include a clear explanation of the data structures that will be required and also explain the purpose and functionality of the map() and reduce() functions in solving this problem.   12 MARKS